A Fractal Manifold with Application to Rocketry

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Rocket engines generally inject fuel and oxidizer into the combustion chamber using separate nozzles. To get the most complete and rapid combustion, it would be better to use a grid of injectors of the form

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HOHOHOHOH
OHOHOHOHO
HOHOHOHOH
OHOHOHOHO
HOHOHOHOH
OHOHOHOHO
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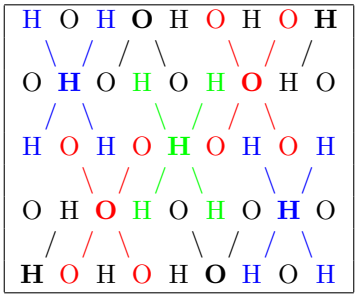
where H represents a fuel injector and O represents an oxidizer injector.

One way to achieve this is to form a manifold from thin layers, where each layer connects 5 holes on one side to 1 on the other:



The diagonal lines show the locations of slanted holes drilled through the layer, where the hole on the other side is directly under the center hole of each cluster (shown in boldface). Some of the clusters are shown in color.

Note that every hole (except those on the outside rows) is part of a cluster, and that fuel lines connect only to other fuel lines and oxidizer lines connect only to other oxidizer lines. If one were to plot the locations of the holes on the other side, they would again form a grid as in the first diagram (only further apart and rotated). The pattern for the clusters shown here is 2 holes to the right and 1 up. Both the grid distances and the hole diameters increase by the $\sqrt{5}$ across each layer.

One could connect a series of such layers together, limited in number only by the minimum size of a hole one can drill diagonally through a thin layer, or the ability to get the holes to line up between layers, or the ability to keep the layers from separating under pressure. On the other end, at some point one should probably switch over to a more conventional manifold, such as that used by the Rocketdyne F1 engine.

It might be a good idea to add one layer of straight, tapered holes at the small end to handle the flow transition and heat transfer.